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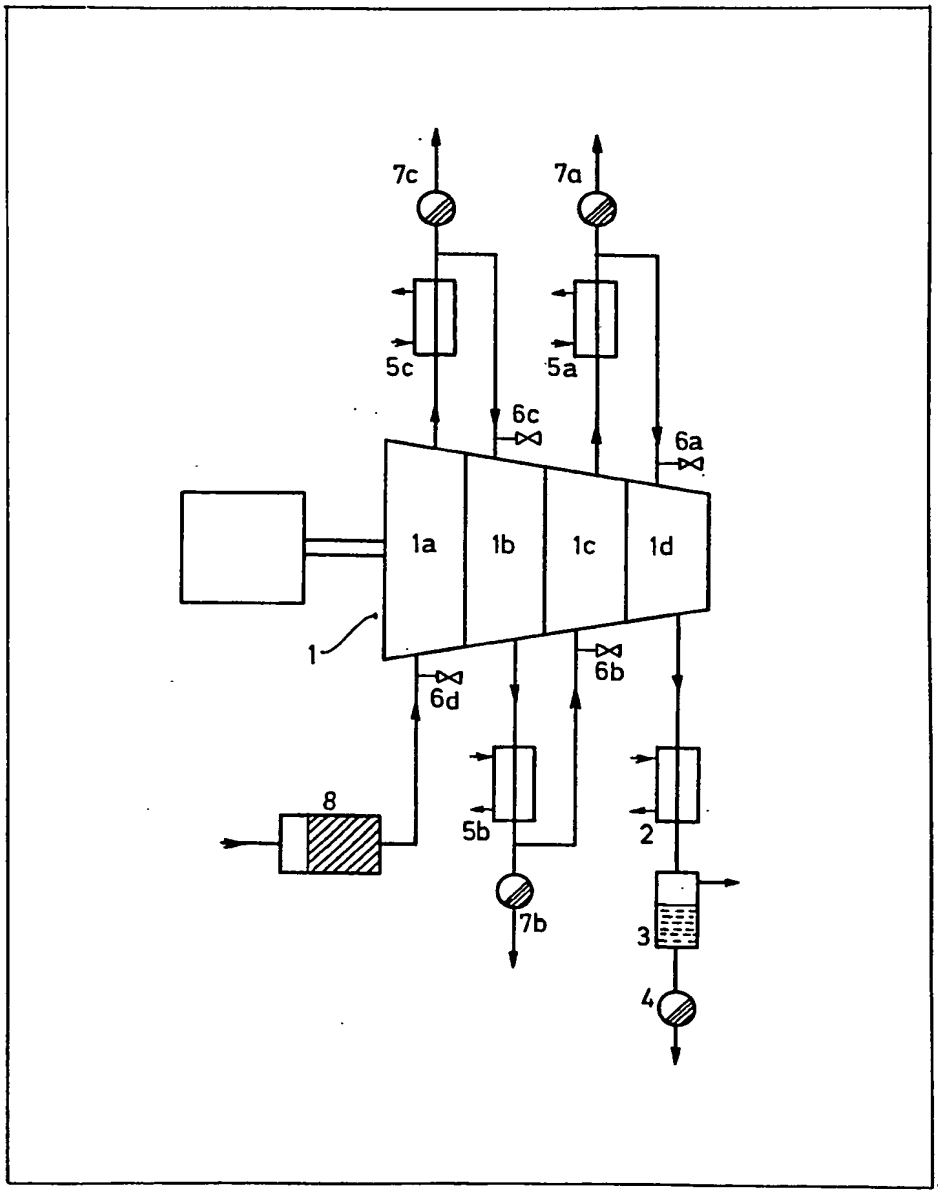
(54) Cleaning of Multi-Stage Turbo-Compressors for Gases

(57) The individual stages or individual groups of stages are cleaned by introducing a cleaning fluid, with the turbo-compressor running, into the gas feed or the particular stage or group of stages to be cleaned and taking off the cleaning fluid, laden with the dissolved-off soiling matter, after it has passed through the stage or group of stages, suitably via condensate removal vessels. The last stage or group of stage 1*d* is treated first, a suitable solvent or other cleaning fluid being introduced via a valve 6*a* and the dirt-laden cleaning fluid being withdrawn via a condensate removal vessel 4. The process is repeated for the remaining stages or groups of stages 1*c*, 1*b*, 1*a* in succession.



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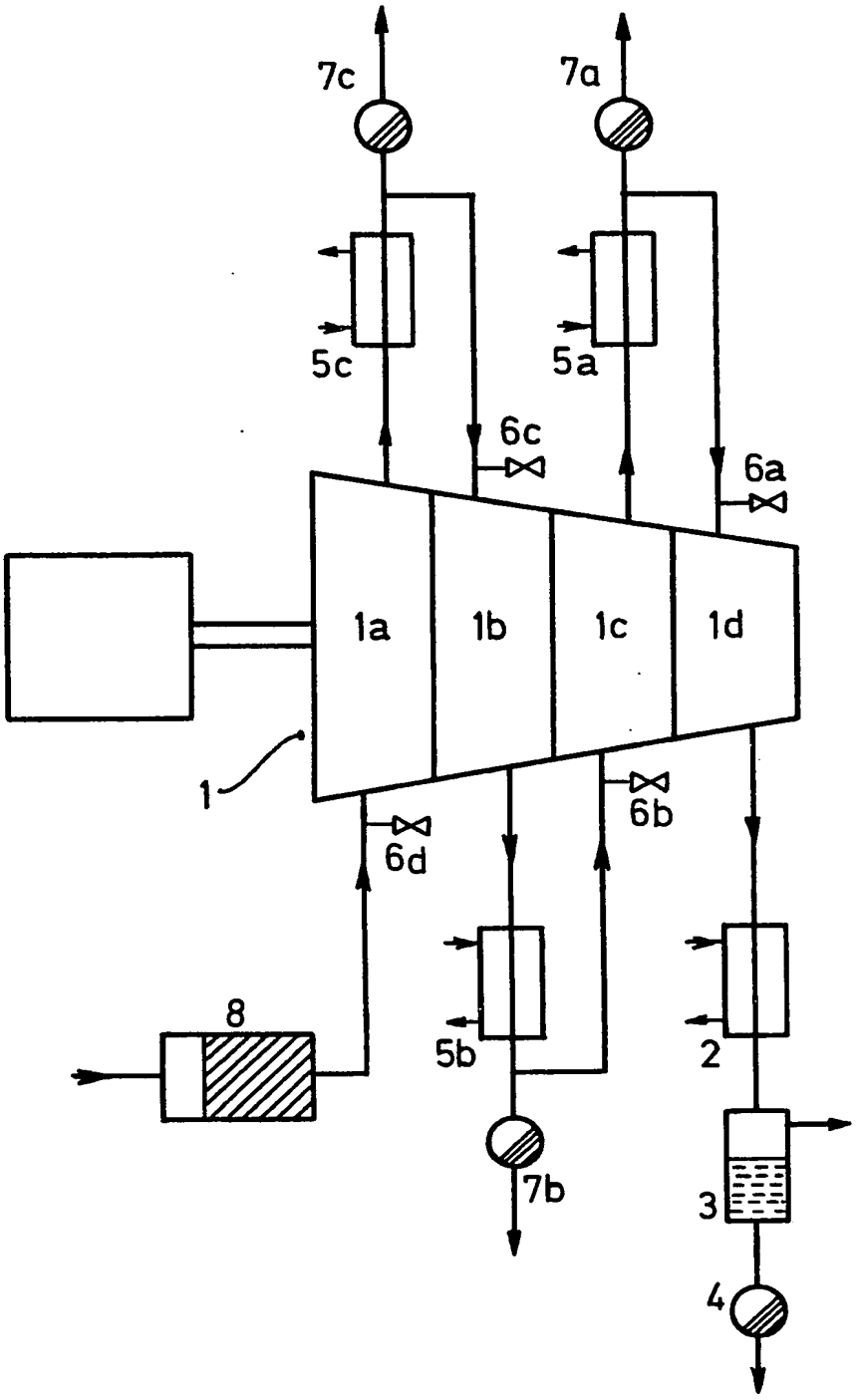
7c
7a
5c
5a
6c
6a
1a
1b
1c
1d
1
6d
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8
5b
2
7b
3
4

SPECIFICATION

Cleaning of Multi-Stage Turbo-Compressors for Gases

The present invention relates to a process, using a cleaning fluid, for cleaning a multi-stage turbo-compressor for gases in order to remove soiling matter deposited from the gases onto the inner parts of the turbo-compressor.

Multi-stage turbo-compressors are extensively used in industry for compressing gases, for example synthesis gas or air, to the desired final pressure via several stages. It is known that during compression of the gases, particles of soiling matter contained in the gases deposit, in due course, on the inner parts of the turbo-compressor. It is true that in the case of air turbo-compressors filters have already been used upstream of the compressor in order to avoid the formation of deposits. However, it is not possible to prevent—at acceptable expense—very fine dust particles from being carried through the filter and forming a layer of soiling matter on the inner parts of the turbo-compressor such as impellers, guide channels, diffusers, rotor blades and guide blades, and cooling elements of the intercoolers. These deposits result in increased frictional losses, and reductions of cross-section, in the flow channels, which reductions lead, within a short time, to appreciable decreases in performance, such as a drop in the throughput and a rise in the specific energy consumption. Frequently, surging of the turbo-compressor shows that the latter can no longer be run safely at the required operating pressure. In order to make it possible again to run the turbo-compressor under normal operating conditions, it ultimately becomes necessary to clean it to remove the deposits.

In the conventional processes for cleaning the turbo-compressor, the latter was as a rule stopped and opened up, which frequently involved dismantling the cooling elements of the intercooler. The soiled inner parts of the turbo-compressor were then in general first cleaned mechanically or treated with a cleaning fluid, for example a solvent or water. However, these conventional methods of cleaning have the disadvantage that stopping the turbo-compressor results in substantial losses of production. Furthermore, the conventional methods of cleaning are very expensive.

We have found an advantageous process, using a cleaning fluid, for cleaning a multi-stage turbo-compressor for gases in order to remove soiling matter deposited from the gases onto the inner parts of the turbo-compressor, wherein the individual pressure stages or individual groups of pressure stages are cleaned by introducing the cleaning fluid, with the turbocompressor running into the gas feed for the particular pressure stage to be cleaned and taking off the cleaning fluid, laden with the dissolved-off soiling matter, after it has passed through the pressure stage or group of pressure stages.

In an advantageous embodiment of the process, the pressure stages and/or groups of pressure stages of the multi-stage turbo-compressor are cleaned individually in succession, in decreasing pressure sequence, starting with the highest pressure stage or with the group of pressure stages which are at the highest pressures.

The novel cleaning process has the advantage that it is not necessary to stop the turbo-compressor during cleaning so that it becomes possible to avoid production losses. Furthermore, the expensive opening of the turbo-compressor, and the removal of the flow components and of the cooler bundle, are avoided in the novel process.

The cleaning method according to the invention may be applied in general to multi-stage turbo-compressors of radial and axial construction. If there is only one pressure stage upstream of an intercooler or final cooler, the particular pressure stage is advantageously individually cleaned to remove the deposits. If, on the other hand, there are two or more pressure stages upstream of an intercooler or final cooler and without an intervening cooler, these pressure stages are in general cleaned conjointly, being treated as a pressure stage group. The process according to the invention is applicable both to multi-stage turbo-compressors with pressure stages which are exclusively cleaned individually, and to multi-stage turbo-compressors in which it is exclusively groups of pressure stages which are cleaned. However, the novel process is also applicable to multi-stage turbo-compressors in which one or more pressure stages to be cleaned individually are combined with two or more pressure stages to be cleaned in groups. In general, the process according to the invention is employed for multi-stage turbo-compressors with from 2 to 15, preferably from 2 to 10, especially from 2 to 8, pressure stages and/or groups of pressure stages.

In general, especially in the case of multi-stage air turbo-compressors, the multi-stage turbo-compressors are equipped with intercoolers between the individual pressure stages or groups of pressure stages and may or may not be equipped with a final cooler which is located down-stream of the last pressure stage, which is operated at the highest pressure. As a rule, the intercooler and final cooler are outside the compressor housing. However, the intermediate cooling and final cooling of the gas can also take place within the compressor housing, for example, by using flanged-on cooler housings. Advantageously, a separating device, for example a separating vessel, for the cleaning fluid is inserted downstream of each cooled pressure stage or group of pressure stages.

Examples of gases to be compressed in the compressors to which the process according to the invention may be applied, are hydrocarbons, e.g. methane, ethane, propane, ethylene, propylene, C_4-hydrocarbons and natural gas,

hydrogen-containing gases, e.g. synthesis gas, chlorine, CO_2, ammonia, nitrous fumes, fluorohydrocarbons and in particular air.

Examples of suitable cleaning fluids for cleaning a multi-stage turbo-compressor in accordance with the invention are washing oils, organic solvents, e.g. alcohols, carboxylic acid amides, e.g. dimethylformamide and N-methylpyrrolidone, and hydrocarbons and chlorohydrocarbons. Water, which may or may not contain cleaning agents, e.g. detergents, may be used with particular advantage as the cleaning fluid, especially when cleaning multi-stage air turbo-compressors.

According to the invention, the multi-stage turbo-compressor is cleaned, to remove deposits of soiling matter on the inner parts, by cleaning the individual pressure stages or individual groups of pressure stages by introducing the cleaning fluid, with the turbo-compressor running, into the gas feed for the particular pressure stage or group of pressure stages to be cleaned and taking off the cleaning fluid, laden with the dissolved-off soiling matter, after it has passed through the pressure stage or group of pressure stages. The cleaning fluid is advantageously introduced between the intercooler, immediately upstream of the particular pressure stage or group of pressure stages, and the pressure stage or group of pressure stages concerned, into the gas feedline leading to the pressure stage or group of pressure stages, for example through an inlet nozzle attached to the gas feedline. However, it is also possible to introduce the cleaning fluid upstream of the relevant intercooler, but downstream of the preceding pressure stage or group of pressure stages. For cleaning the first pressure stage or group of pressure stages, which is operated at the lowest pressure, the cleaning fluid is in general introduced into the intake line, advantageously between the filter, if any, and the first pressure stage. As a rule, cleaning fluid is introduced into the pressure stage or group of pressure stages concerned until the deposits of soiling matter have been dissolved off, which can be monitored easily by observing the decreasing degree of soiling of the cleaning fluid, laden with dissolved-off soiling matter, which is drawn off.

The cleaning fluid, laden with dissolved-off soiling matter, which is obtained after passing through the pressure stage, or group of pressure stages, which is to be cleaned, is advantageously drawn off by discharging it without releasing the pressure of the system, for example using such discharge devices as condensate removers. Advantageousely, such a discharge device is provided downstream of each pressure stage or group of pressure stages. When cleaning the last pressure stage or group of pressure stages, which is under the highest pressure, it is advantageous to draw off the entire cleaning fluid, laden with dissolved-off soiling matter, from the discharge unit downstream of the last pressure stage. When cleaning one of the earlier pressure stages or groups of pressure stages, which is under a lower pressure, the cleaning fluid laden with the dissolved-off soiling matter can be predominantly drawn off from the discharge unit downstream of the particular pressure stage or group of pressure stages. However, it is also possible to allow all or part of the cleaning fluid, laden with dissolved-off soiling matter, obtained from a preceding pressure stage or group of pressure stages, to pass through one or more of the subsequent pressure stages and/or groups of pressure stages and to draw it off, for example, via one or more of the discharge units which are provided downstream of each of the subsequent pressure stages and/or groups of pressure stages.

It is particularly advantageous to effect the cleaning, according to the invention, of the multi-stage turbo-compressor by cleaning the pressure stages and/or groups of pressure stages individually in succession in decreasing pressure sequence, starting with the highest pressure stage, during the normal operation of the turbo-compressor.

The accompanying drawing shows, diagrammatically, one embodiment of a system for carrying out the process according to the invention. Referring to the drawing, an air turbo-compressor (1) with, for example, 4 pressure stages or groups of pressure stages (1a to d) draws in air from the atmosphere through the filter (8) and compresses it to the final pressure of, for example, 6 bars. Advantageously, water is used as the cleaning fluid for cleaning the air turbo-compressor in order to remove soiling matter deposited from the air onto the inner parts of the compressor. After each stage or group of stages, intercoolers (5a to c) are provided so as to achieve inexpensive substantially isothermal compression. Downstream of the last pressure stage or pressure stage group (1d), a final cooler (2) with water separator (3) and condensate remover (4) is, in general, provided. Water inlet nozzles (6a to d) are fitted to the intake lead and downstream of each intercooler. In addition, discharge vessels (7a to c), which are intended to discharge any condensate which may be formed during operation, are provided downstream of each of the intercoolers (5a to c).

The process of cleaning the air turbo-compressor is started, for example, by slowly opening the valve (6a) for the introduction of water, whereby the last pressure stage or pressure stage group (1d) is flushed by the air/water mixture. The water laden with the soiling matter which has been dissolved off is taken off at the discharge vessel (4). The water discharged, which initially is dark due to the soiling matter dissolved off, becomes paler in the course of the cleaning operation. As soon as the water discharged no longer contains any dissolved-off soiling matter, the operation of cleaning the last pressure stage or pressure stage group is terminated by closing the water inlet (6a). Thereafter, water is introduced via valve (6b) in order to clean the penultimate pressure stage or pressure stage group (1c), which is operated at

the second-highest pressure. The greater part of the water which is laden with dissolved-off soiling matter and which is initially dark is drawn off via the discharge vessel (7a) whilst the lesser part is drawn off via the final discharge vessel (4). After having dissolved off the deposits of soiling matter in pressure stage or pressure stage group (1c) and the intercooler (5a), the operation of cleaning the penultimate pressure stage or pressure stage group and the intercooler (5a) is terminated by closing the valve (6b). Thereafter, pressure stage or pressure stage group (1b) and the intercooler (5b), and finally, pressure stage or pressure stage group (1a) and the intercooler (5c), are cleaned in the corresponding manner.

Claims

1. A process, using a cleaning fluid, for cleaning a multi-stage turbo-compressor for gases in order to remove soiling matter deposited from the gases onto the inner parts of the turbo-compressor, wherein the individual pressure stages or individual groups of pressure stages of the turbo-compressor are cleaned by introducing the cleaning fluid, with the turbo-compressor running, into the gas feed for the particular pressure stage or group of pressure stages to be cleaned and taking off the cleaning fluid, laden with the dissolved-off soiling matter, after it has passed through the pressure stage or group of pressure stages.

2. A process as claimed in claim 1, wherein the pressure stages and/or groups of pressure stages of the multi-stage turbo-compressor are cleaned individually in succession, in decreasing pressure sequence, starting with the highest pressure stage or with the group of pressure stages which are at the highest pressures.

3. A process as claimed in claim 1 or 2, wherein the cleaning of the turbo-compressor is carried out during normal operation of the latter, the cleaning fluid laden with soiling matter being removed via discharge vessels.

4. A process as claimed in any of claims 1 to 3, wherein a multi-stage air turbo-compressor is cleaned.

5. A process as claimed in any of claims 1 to 4, wherein the cleaning fluid is water, optionally containing a detergent.

6. A process as claimed in any of claims 1 to 5, wherein the cleaning fluid is introduced between the pressure stage or group of pressure stages to be cleaned and an intercooler immediately upstream thereof or, in the case of the first pressure stage or group of pressure stages, into the intake line for the turbo-compressor.

7. A process for cleaning a multistage turbo-compressor for gases carried out substantially as hereinbefore described with reference to the accompanying drawing.

New Claims filed on 12 June 1979.

New Claims:—

8. A process, using a cleaning fluid, for cleaning a multi-stage turbo-compressor for gases in order to remove soiling matter deposited from the gases onto the inner parts of the turbo-compressor, wherein the individual pressure stages or individual groups of pressure stages of the turbo-compressor are cleaned, with the turbo-compressor running, individually in succession, in decreasing pressure sequence, starting with the highest pressure stage or with the group of pressure stages which are at the highest pressures.

9. A process as claimed in claim 8, wherein a multi-stage turbo-compressor equipped with intercoolers between the individual pressure stages or groups of pressure stages is cleaned.

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